

# GLOBAL AND REGIONAL POTENTIAL FOR BIOMASS ENERGY WITH CARBON CAPTURE AND STORAGE

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September 19-22, 2011  
Poland

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CaRe Tech 2011

# The aim of this presentation



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Objectives

TIAM-FR and Scenarios

Results

Conclusion

**2°C objective expressed since COP15 induces CO<sub>2</sub> mitigation policies which involve transformation of the world energy system and technological choices**

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## **Evolution of the world energy system**

- ❑ What could be the future power mix?
- ❑ What technological choices?

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Objectives

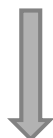
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- ❑ What could be the future power mix?
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## **CCS technologies as a promising option**

- ❑ What could be the place of CCS in the power generation?
- ❑ What could be the place of BECCS in the power generation?

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## **CCS technologies as a promising option**

- ❑ What could be the place of CCS in the power generation?
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## **Developed and developing countries perspective**

- ❑ What global and regional potential of CCS and BECCS ?

# Model: TIAM-Fr, the French world version of TIMES



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TIAM-FR and Scenarios

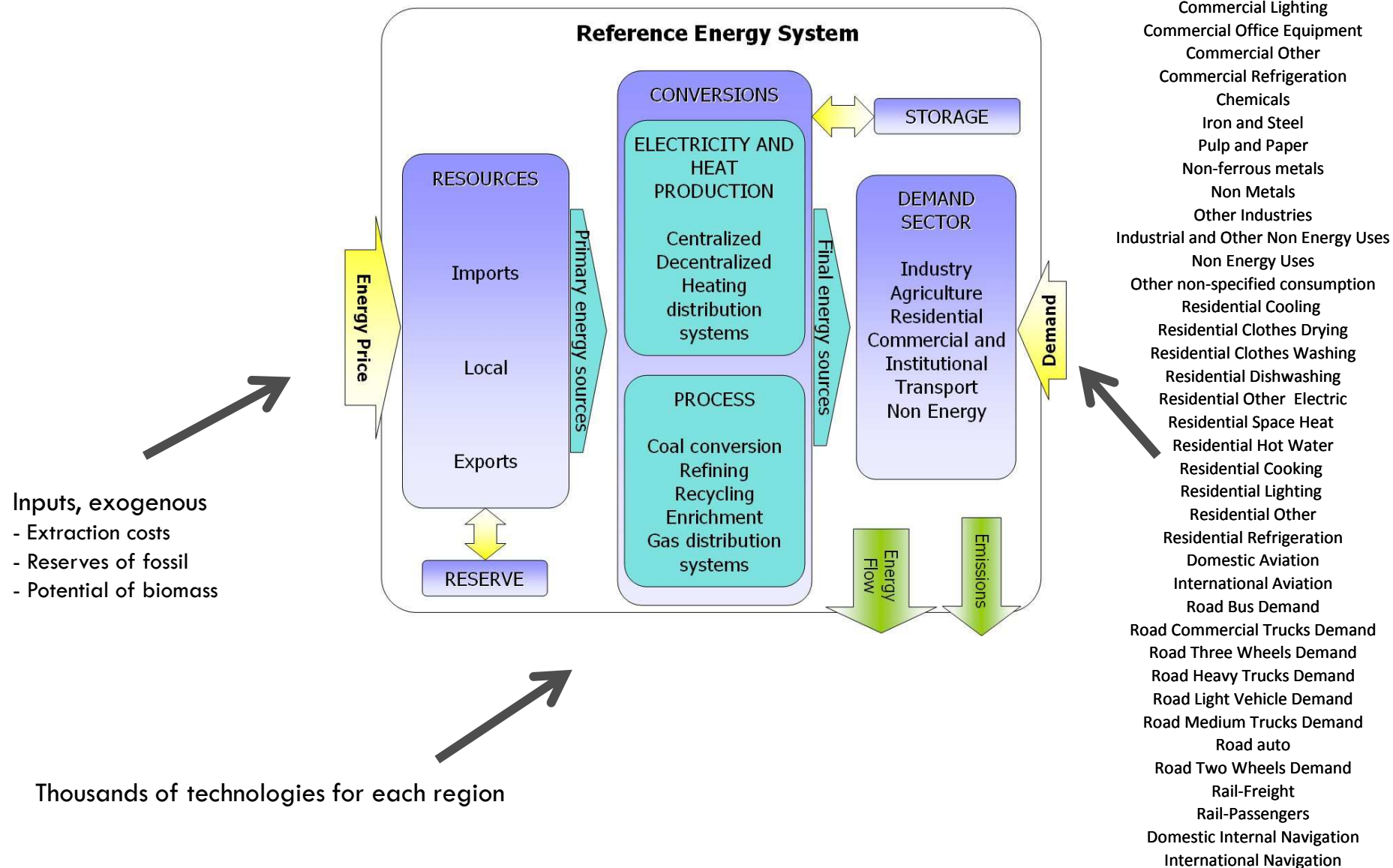
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- TIMES Integrated Assessment Model developed by ETSAP- IEA (Energy Technology Systems Analysis Program)
- A technological detailed bottom-up energy system model

# Simplified RES

## Demand for energy services



# Model: TIAM-Fr, the French world version of TIMES



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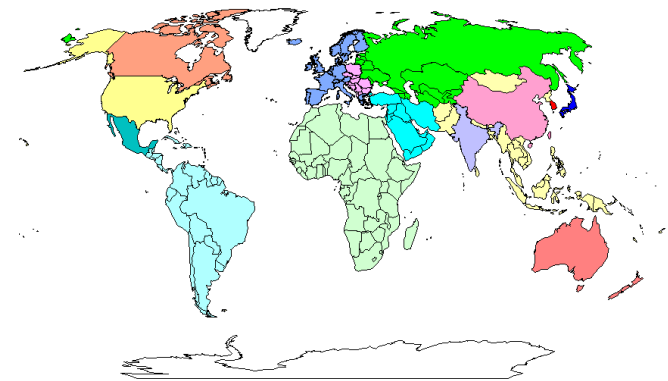
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- TIMES Integrated Assessment Model developed by ETSAP- IEA (Energy Technology Systems Analysis Program)
- A technological detailed bottom-up energy system model
- A linear programming model minimizing the total discounted cost of the system
- A geographically integrated model in 15 world regions
- A time horizon from 2005 to 2100
- GHG emissions and integrated climate module
  - CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O
  - Atmospheric concentration and temperature changes
- Carbon capture and sequestration technologies
  - Fossil and Bio-Energies CCS





# Specification of scenarios



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TIAM-FR and Scenarios

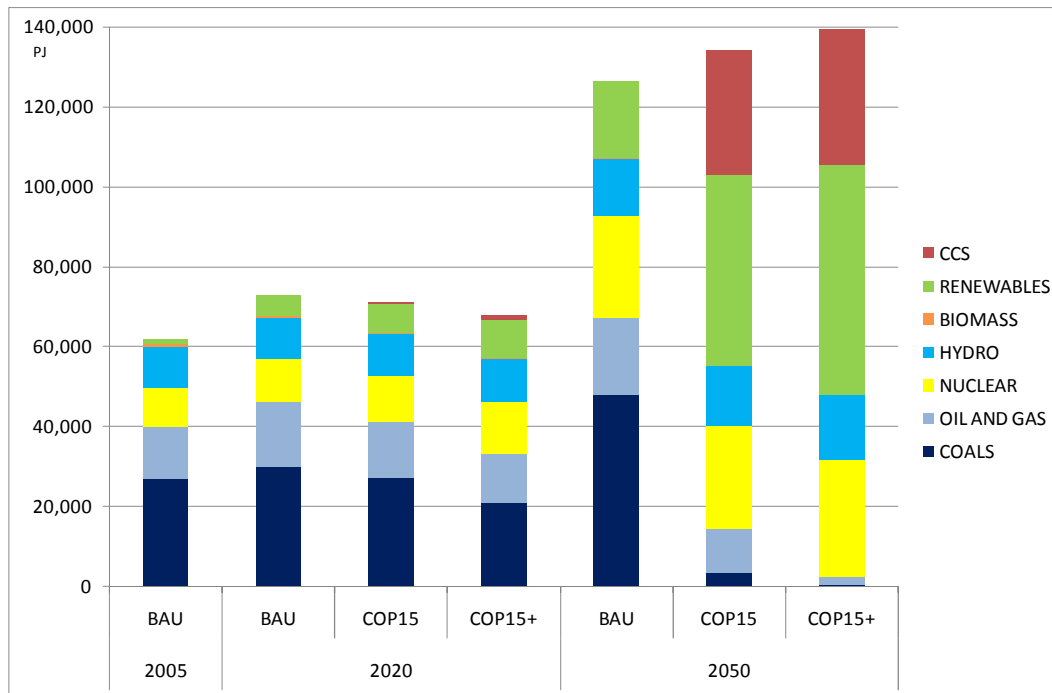
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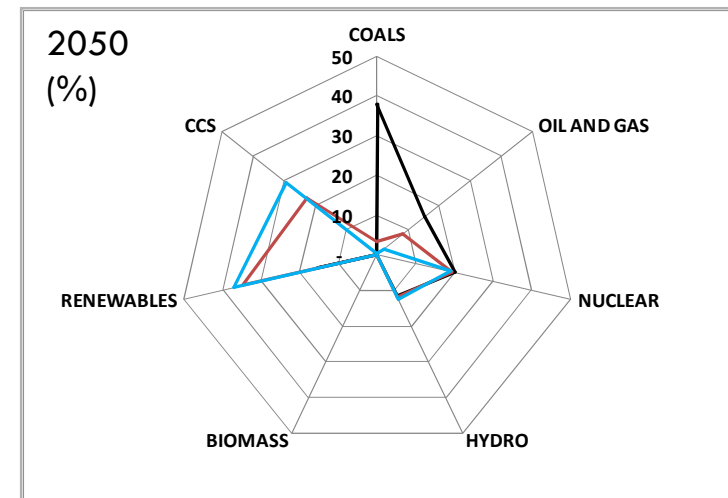
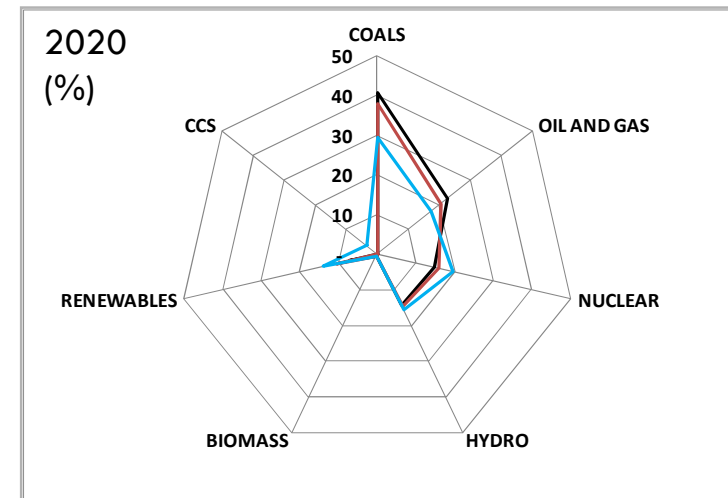
- **COP15** – A regional scenario considering post COP15 pledges in 2020 and assuming new targets for 2050
  - The lowest CO<sub>2</sub> mitigation targets by 2020 expressed by Europe, the USA, Australia, Canada, Japan, China and India
  - Assumptions in 2050 representing the international convergence in terms of mitigation for these developed and fast developing countries
  
- **COP15plus** – A coupled regional and global scenario in line with the consensual 2°C objective
  - The lowest CO<sub>2</sub> mitigation targets by 2020 expressed by Europe, the USA, Australia, Canada, Japan, China and India
  - A limitation of the world CO<sub>2</sub> emissions to 50% in 2050 by comparison with 2000

# Results

# World power generation (PJ) and mix (%)



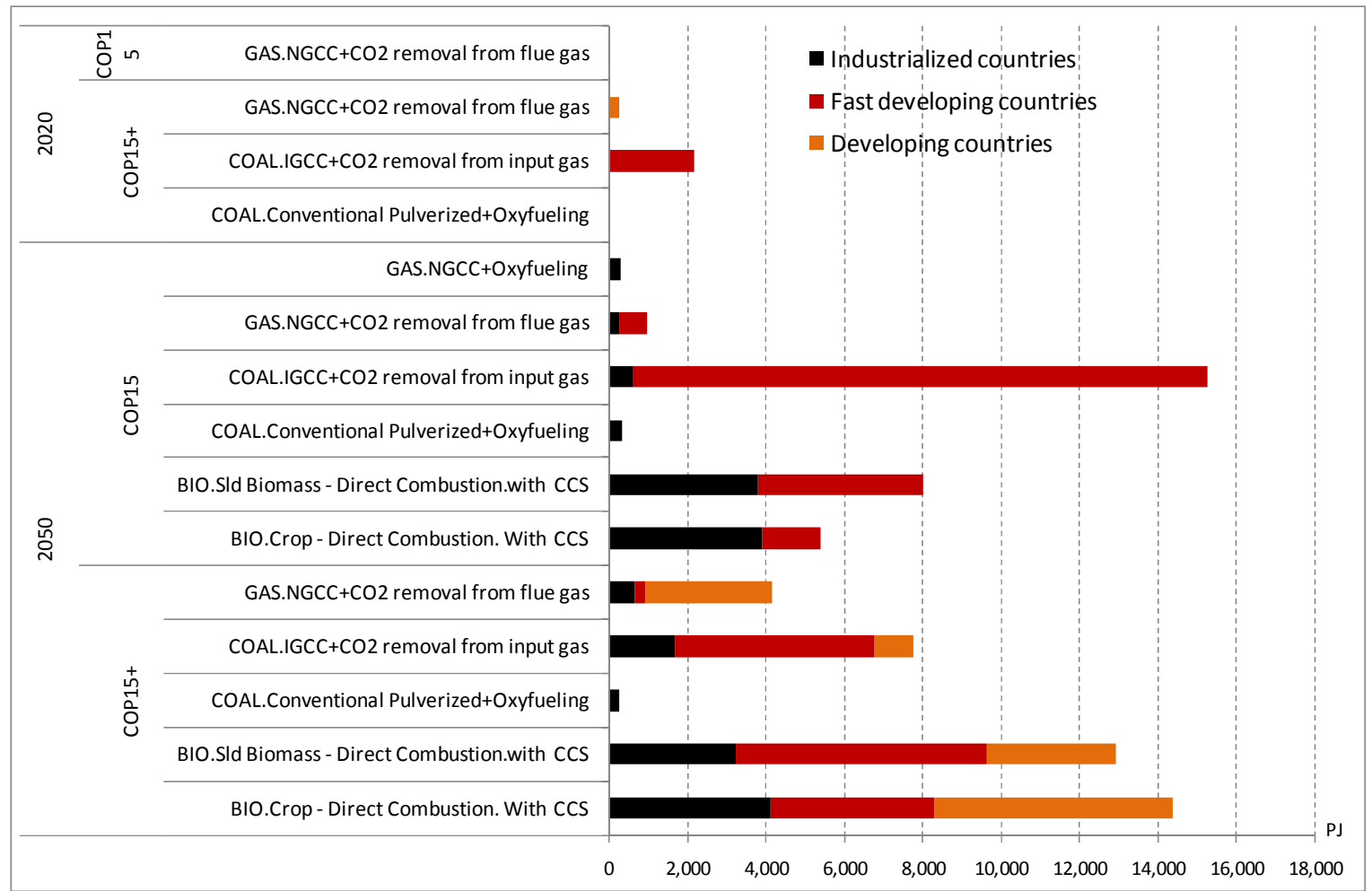
- 2020: Energy switch from fossil to nuclear and renewables in COP15+
- 2050: Deployment of renewables and CCS technologies



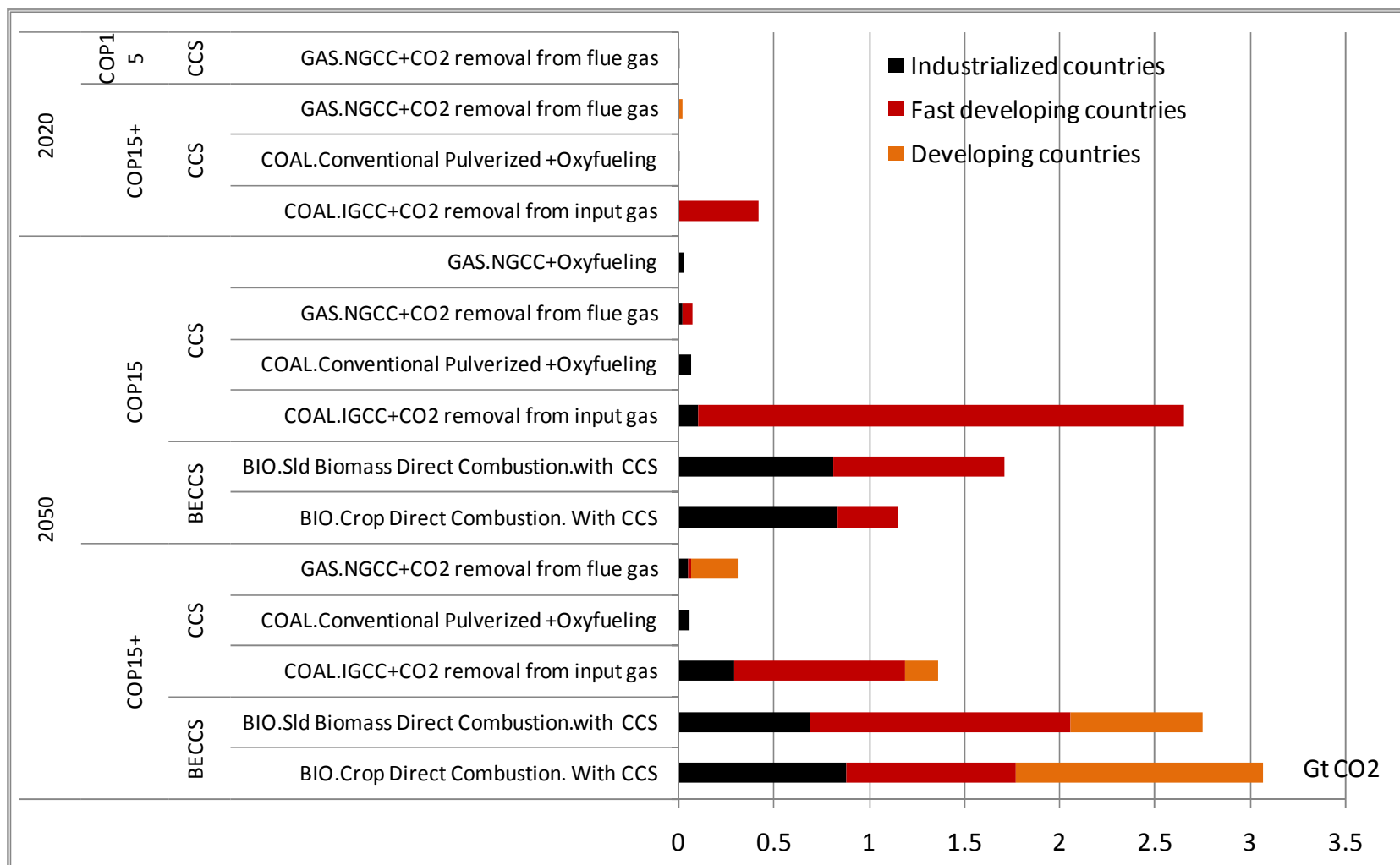
—BAU —COP15 —COP15+



# Regional power generation by plants with CCS (PJ)



# Regional CO<sub>2</sub> sequestered by power plants with CCS (Gt)



# Conclusion

# The technological progress is a significant issue



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- The deployment of CCS as a response of carbon constraints
  - 23 % and 29% of CCS in the power mix respectively in COP15 and COP15+ scenarios
  - Investment in BECCS in developed and developing countries
- But: feasibility of this development
  - Safety problem: Social acceptability and carbon leak back into the atmosphere
  - Commercialization limits: high costs, scale of production, time of deployment
  - The place of BECCS in developing countries: food competition
- Further development
  - Investigate different pathways of incentives policy of biomass and biomass + CCS



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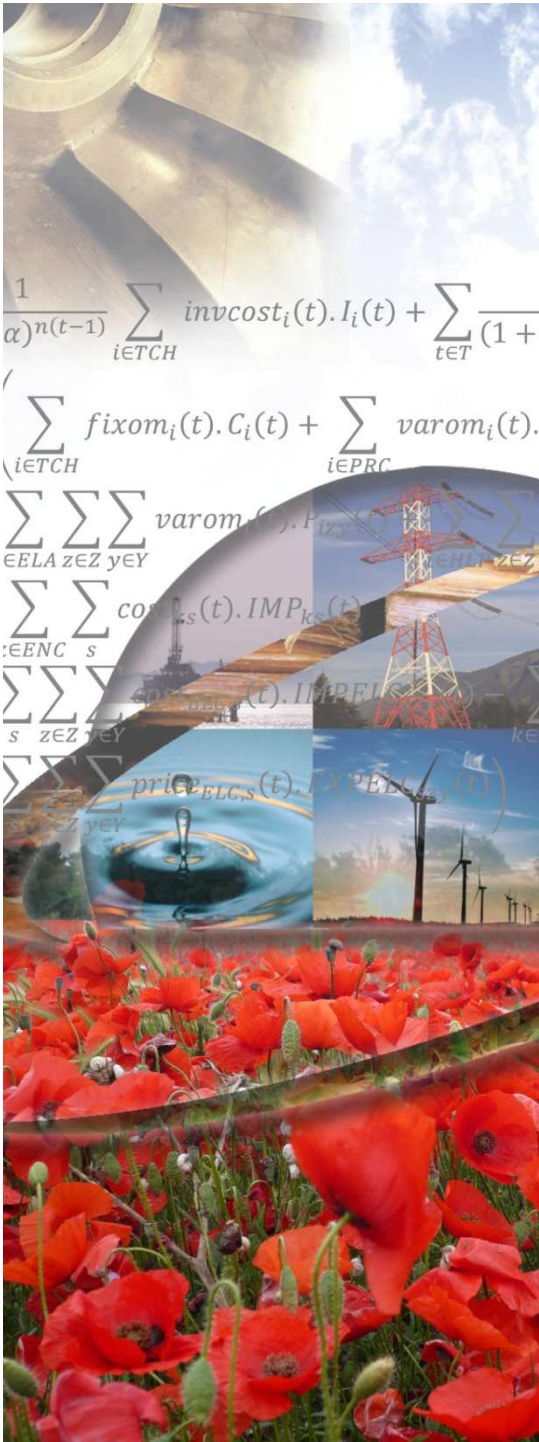
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**THANK YOU FOR YOUR ATTENTION**

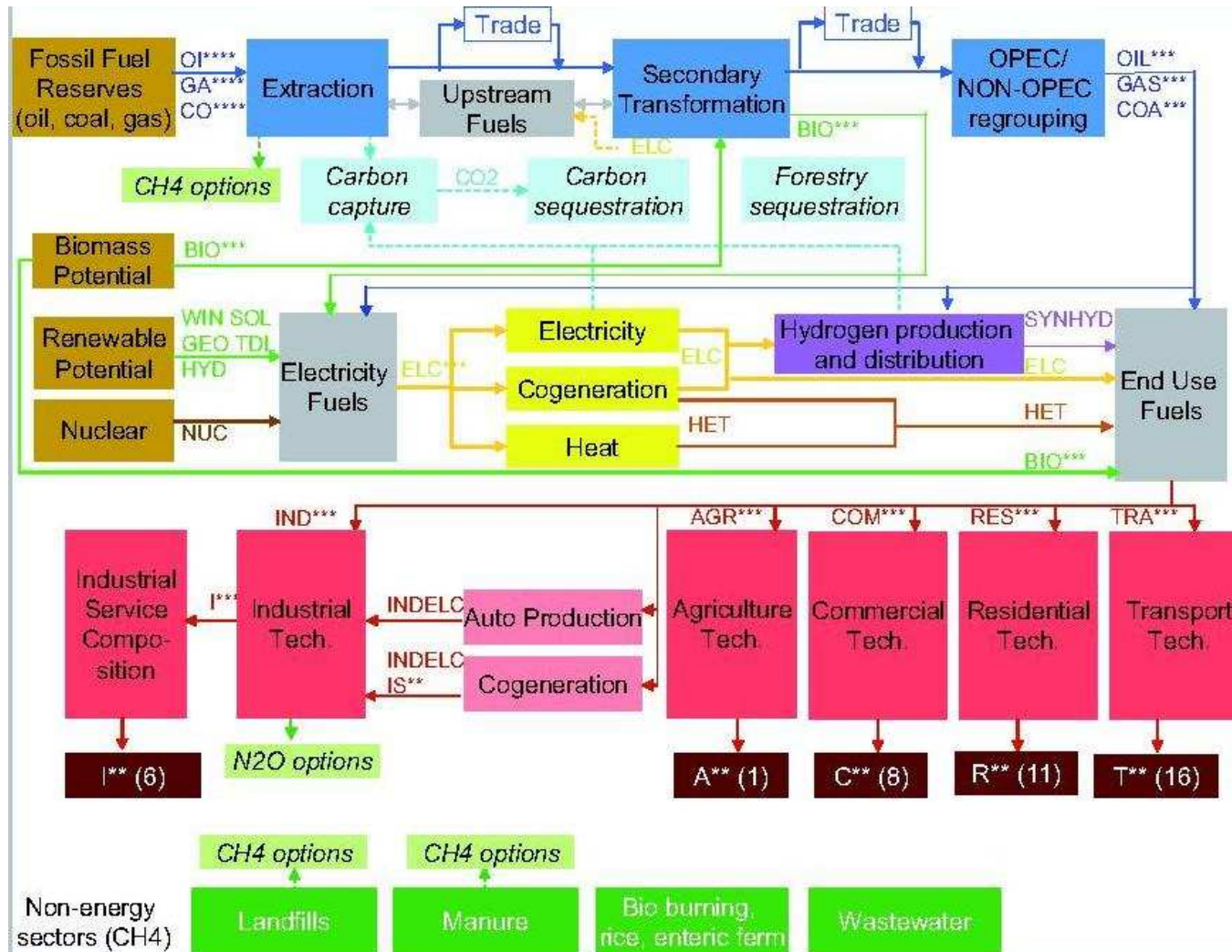
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# Annexes

# Reference Energy System



# Specification of scenarios



**COP15**

A regional scenario considering post COP15 pledges in 2020 and assuming new targets for 2050

Regions	Year ref.	Year target	Targets	Reduc. type	Level CO2 (Gt)
WEU-EEU	1990	2020	20%	Emi. Reduc.	3,54
		2050	80%		0,89
USA	2005	2020	17%	Emi. Reduc.	4,74
		2050	83%		0,97
AUS	2000	2020	5%	Emi. Reduc.	0,37
		2050	80%		0,08
CAN	2005	2020	17%	Emi. Reduc.	0,47
		2050	83%		0,1
JPN	1990	2020	25%	Emi. Reduc.	0,79
		2050	80%		0,21
CHI	2005	2020	40%	CO2 intensity	6,45
		2050	10%	Emi. Reduc.	4,12
IND	2005	2020	20%	CO2 intensity	2,16
		2050	10%	Emi. Reduc.	0,98

**COP15+**

A coupled regional and global scenario in line with the consensual 2°C objective

Regions	Year ref.	Year target	Targets	Reduc. Type	Level CO2 (Gt)
WORLD	2000	2050	50%	Emi. Reduc.	11,16

# Evited CO<sub>2</sub> emissions due to the carbon constraint



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Objectives	TIAM-FR and Scenarios	Results	Conclusion
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Period	Scenario	Industrialized countries	Fast developing countries	Developing countries	World
2020	BAU	11	8	8	26
	<b>COP15</b>	<b>-1.2</b>	<b>-0.2</b>	<b>0.1</b>	<b>-1.3</b>
	<b>COP15+</b>	<b>-1.5</b>	<b>-1.5</b>	<b>-2.3</b>	<b>-5.3</b>
2050	BAU	11	17	12	41
	<b>COP15</b>	<b>-9</b>	<b>-12</b>	<b>0</b>	<b>-21</b>
	<b>COP15+</b>	<b>-7</b>	<b>-15</b>	<b>-8</b>	<b>-30</b>

# World power mix (%)

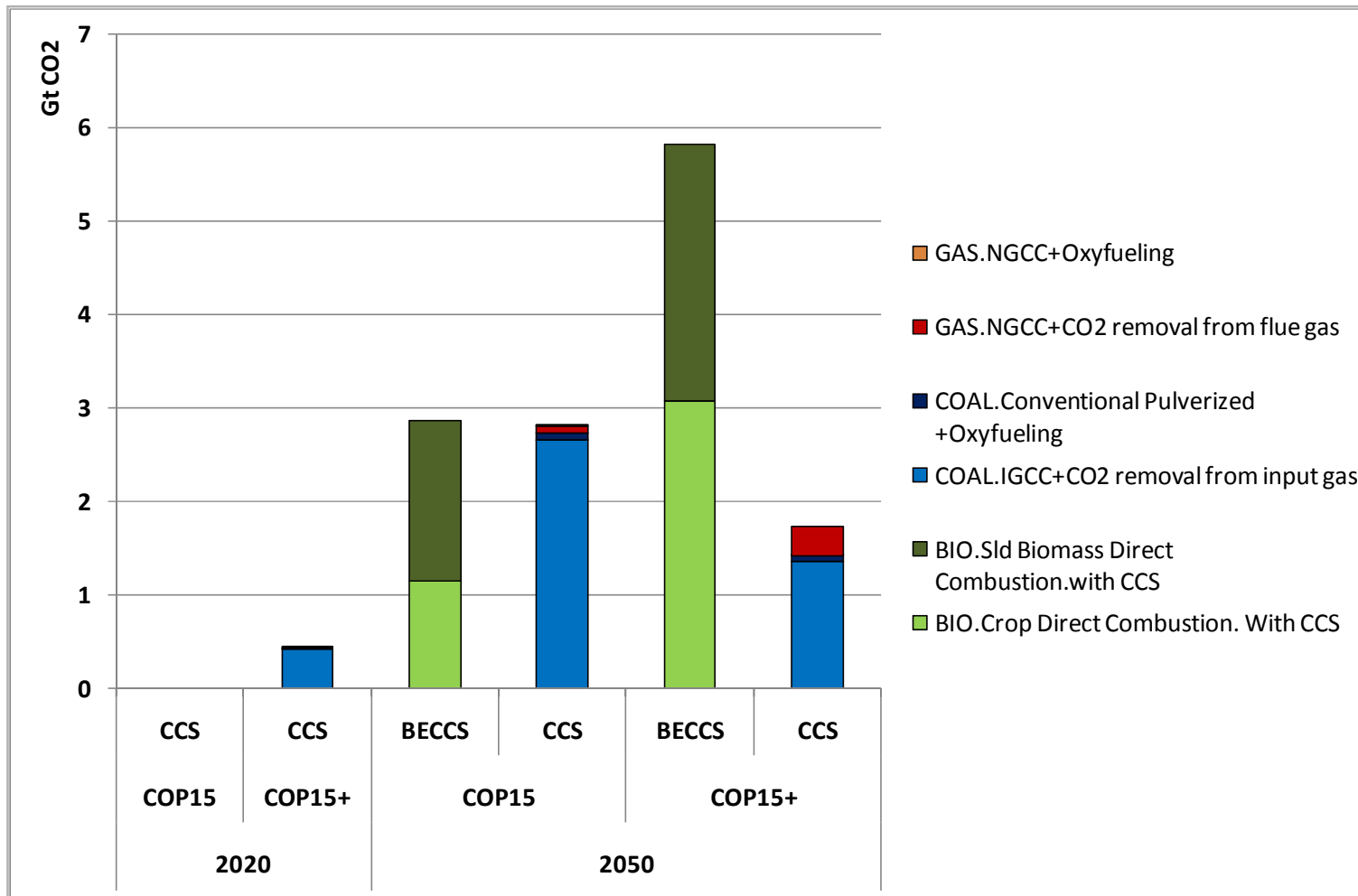


Objectives	TIAM-FR and Scenarios	Results	Conclusion
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Period	Scenario	COALS	OIL AND GAS	NUCLEAR	HYDRO	BIOMASS	RENEWABLES	CCS
2005	BAU	44	21	16	17	1	2	0
Period	Scenario	COALS	OIL AND GAS	NUCLEAR	HYDRO	BIOMASS	RENEWABLES	CCS
2020	BAU	41	23	15	14	1	7	0
	COP15	38	20	16	15	1	11	0
	COP15+	29	17	19	16	1	14	4
Period	Scenario	COALS	OIL AND GAS	NUCLEAR	HYDRO	BIOMASS	RENEWABLES	CCS
2050	BAU	38	15	20	11	0	15	0
	COP15	3	8	19	12	0	35	23
	COP15+	0	2	19	12	0	37	29



# World CO<sub>2</sub> sequestered by power plants with CCS (Gt)



# Regional power generation by plants with CCS (PJ)



VI/VI

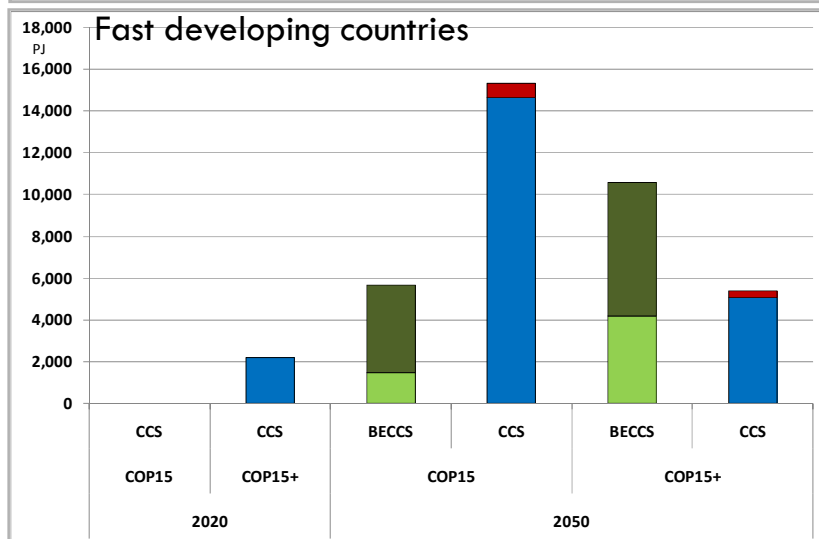
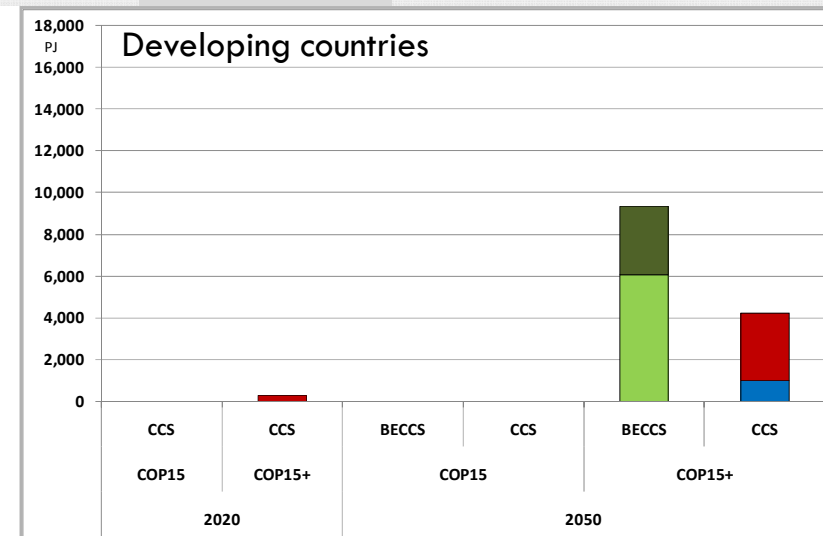
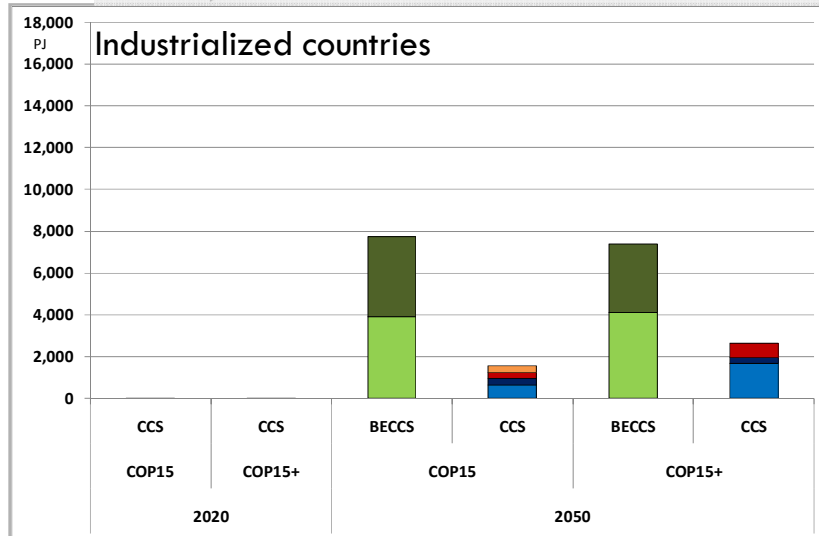
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- GAS.NGCC+Oxyfueling
- GAS.NGCC+CO2 removal from flue gas
- COAL.Conventional Pulverized+Oxyfueling
- COAL.IGCC+CO2 removal from input gas
- BIO.Sld Biomass - Direct Combustion.with CCS
- BIO.Crop - Direct Combustion. With CCS